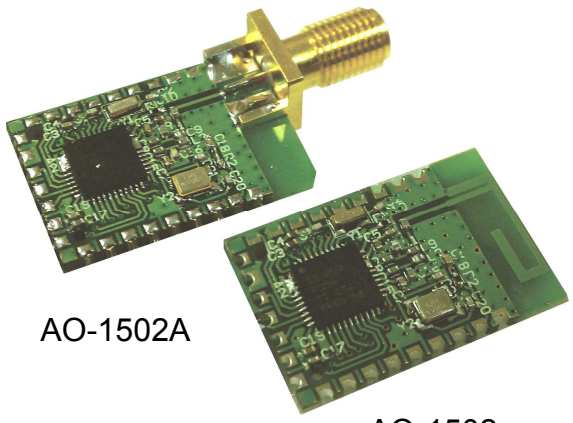
AO-1502/1502A BLE Transceiver Module



AO-1502A

AO-1502

Features

- Reliable wireless transceiver module.
- Compatible with Peer to Peer or Star network configurations.
- AO-1502 with on board PCB ANT with 150M range (LOS).
- AO-1502A with external ANT.

Applications

- Wireless sensor network (WSN).
- Smart meter.
- RF remote control.
- 2.4 GHz IEEE 802.15.4 network.
- Home and building automation.
- Industrial control and surveillance.
- Set top box (STB).
- Smart energy.
- Wireless RS232 / RS485 / RS422

Introduction

AO-1502 BLE Transceiver Module, which uses the latest TI CC2541 ZigBee chip, is designed for both Bluetooth low energy and proprietary 2.4 GHz applications. This module integrated high efficiency RF transceiver, 8051 MCU, 8 KB RAM, 256 KB flash memory, and other functional elements to work with various peripheral devices. It is highly suited for systems where ultra-low power consumption is required.

It is also suitable for systems targeting compliance with worldwide radio frequency such as regulations: ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan), etc.

Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTE
Storage Temperature	T_S	–40	85	°C	
Supply Voltage	*Vcc*	-0.3	3.9	V	
Input Voltage	V_{IN}	2	*3.6*	V	
Operating Current	I_{OP}	---	40	mA	
Input RF level	RF_L	---	10	dBm	

Recommended Operating Conditions

PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTE
Operating ambient temperature range	T_A	–40	85	°C	
Supply Voltage	*Vcc*	-0.3	3.9	V	
Operating Input Voltage	V_{IN}	2	*3.6*	V	
Operating Current	$I_{TX} + I_{RX}$	---	69.2	mA	

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Electrical Characteristics

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
I_{core} Core current consumption	PM1 DC Current		270		µA	
	PM2 DC Current		1		µA	
	PM3 DC Current		0.5		µA	
	RX mode, no peripherals active, CPU idle		17.9	24.5	mA	
	TX mode, -20~0dBm output power, no peripherals active, CPU idle		16.8	20.3	mA	
Peripheral Current Consumption						
ADC	When converting		1.2		mA	
Flash	Erase		1		mA	
	Burst write peak current		6		mA	
Wake-up and Timing						
Power mode 1 → active	Digital regulator on, 16-MHz RCOSC and 32-MHz crystal oscillator off. Start-up of 16-MHz RCOSC		4		µs	
Power mode 2 or 3 → active	Digital regulator off, 16-MHz RCOSC and 32-MHz crystal oscillator off. Start-up of regulator and 16-MHz RCOSC		120		µs	
Active → TX or RX	Initially running on 16-MHz RCOSC, with 32-MHz XOSC off		500		µs	
	With 32-MHz XOSC initially on			192	µs	
RX/TX turnaround	Proprietary auto mode		130		µs	
	BLE mode		150			
Radio Part						
RF frequency range	Programmable in 1-MHz steps	2379	---	2496	MHz	
Data rate and modulation format	2 Mbps, GFSK, 500-kHz deviation 2 Mbps, GFSK, 320-kHz deviation 1 Mbps, GFSK, 250-kHz deviation 1 Mbps, GFSK, 160-kHz deviation 250 kbps, GFSK, 160-kHz deviation 500 kbps, MSK 250 kbps, MSK					
Wireless Distance				150	m	
Communication Part						
UART Baud Rate(1)			9600		bps	

(1) Refer to AO-1504/A user guide explanation. The rate can be programmed from 9600 ~ 115200 bps.

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RF Transmitter Electrical Characteristics

V_{IN}= 3.0 V to 3.6 V, T_C = -40 °C to 85 °C, f_c = 2394 MHz to 2507 MHz

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
output power	Delivered to a single-ended 50-Ω load through a balun		0		dBm	maximum
			-23			minimum
Programmable output power range	Delivered to a single-ended 50-Ω load through a balun using 23 dB range minimum recommended output power setting		23		dB	
Optimum load impedance	Differential impedance as seen from the RF port (RF_P and RF_N) toward the antenna		70 +*j*30		Ω	
Spurious emission conducted measurement	f < 1 GHz		-52		dBm	
	f > 1 GHz		-48			

RF Receiver Electrical Characteristics

V_{IN}= 3.0 V to 3.6 V, T_C = -40 °C to 85 °C, f_c = 2440 MHz, 2 Mbps, GFSK, 0.1% BER

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
Receiver sensitivity			-90		dBm	500-kHz Deviation
			-86			320-kHz Deviation
Saturation	BER < 0.1%		-1		dBm	500-kHz Deviation
	BER < 0.1%		-7			320-kHz Deviation
Frequency error tolerance(1)	Including both initial tolerance and drift. Sensitivity better than –67dBm, 250 byte payload. BER 0.1%	-300		300	kHz	500-kHz Deviation
						320-kHz Deviation
Symbol rate error tolerance(2)	Maximum packet length. Sensitivity better than–67dBm, 250 byte payload. BER 0.1%	-120		120	ppm	500-kHz Deviation
						320-kHz Deviation

(1) Difference between center frequency of the received RF signal and local oscillator frequency

(2) Difference between incoming symbol rate and the internally generated symbol rate

V_{IN}= 3.0 V to 3.6 V, T_C = -40 °C to 85 °C, f_c = 2440 MHz, 1 Mbps, GFSK, 0.1% BER

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
Receiver sensitivity			-94(3)	-88(4)	dBm	250-kHz Deviation
			-91(5)			160-kHz Deviation
Saturation	BER < 0.1%		5		dBm	250-kHz Deviation
	BER < 0.1%		0			160-kHz Deviation
Frequency error tolerance(1)	Including both initial tolerance and drift. Sensitivity better than –67dBm, 250 byte payload. BER 0.1%	-250		250	kHz	250-kHz Deviation
						160-kHz Deviation
Symbol rate error tolerance(2)	Maximum packet length. Sensitivity better than–67dBm, 250 byte payload. BER 0.1%	-200		200	ppm	250-kHz Deviation
						160-kHz Deviation

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V_{IN}= 3.0 V to 3.6 V, T_C = -40 °C to 85 °C, f_c = 2440 MHz, 250k bps, GFSK, 160-kHz Deviation, 0.1% BER

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
Receiver sensitivity (based on standard-gain mode)			-98		dBm	
Saturation	BER < 0.1%		0		dBm	
Frequency error tolerance(1)	Including both initial tolerance and drift. Sensitivity better than –67dBm, 250 byte payload. BER 0.1%	-150		150	kHz	
Symbol rate error tolerance(2)	Maximum packet length. Sensitivity better than–67dBm, 250 byte payload. BER 0.1%	-80		80	ppm	

V_{IN}= 3.0 V to 3.6 V, T_C = -40 °C to 85 °C, f_c = 2440 MHz, MSK, 0.1% BER

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
Receiver sensitivity (based on high-gain mode)			-99		dBm	500-kHz
			-99			250-kHz
Saturation	BER < 0.1%		0		dBm	500-kHz
	BER < 0.1%		0			250-kHz
Frequency error tolerance(1)	Including both initial tolerance and drift. Sensitivity better than –67dBm, 250 byte payload. BER 0.1%	-150		150	kHz	500-kHz
						250-kHz
Symbol rate error tolerance(2)	Maximum packet length. Sensitivity better than–67dBm, 250 byte payload. BER 0.1%	-80		80	ppm	500-kHz
						250-kHz

(3) Results based on standard-gain mode

(4) The default value is standard mode

(5) Results based on high-gain mode

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Debug Interface Characteristics

T_A = –40°C to 85°C, V_{DD} = 2 V to 3.6 V, unless otherwise noted.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
Debug clock frequency	fclk_dbg		---	---	12	MHz	(see Figure 1)
Allowed high pulse on clock	t1		35	---	---	ns	(see Figure 1)
Allowed low pulse on clock	t2		35	---	---	ns	(see Figure 1)
EXT_RESET_N low to first falling edge on debug clock	t3		167	---	---	ns	(see Figure 2)
Falling edge on clock to EXT_RESET_N high	t4		83	---	---	ns	(see Figure 2)
EXT_RESET_N high to first debug command	t5		83	---	---	ns	(see Figure 2)
Debug data setup	t6		2	---	---	ns	(see Figure 3)
Debug data hold	t7		4	---	---	ns	(see Figure 3)
Clock-to-data delay	t8	Load = 10 pF	---	---	30	ns	(see Figure 3)

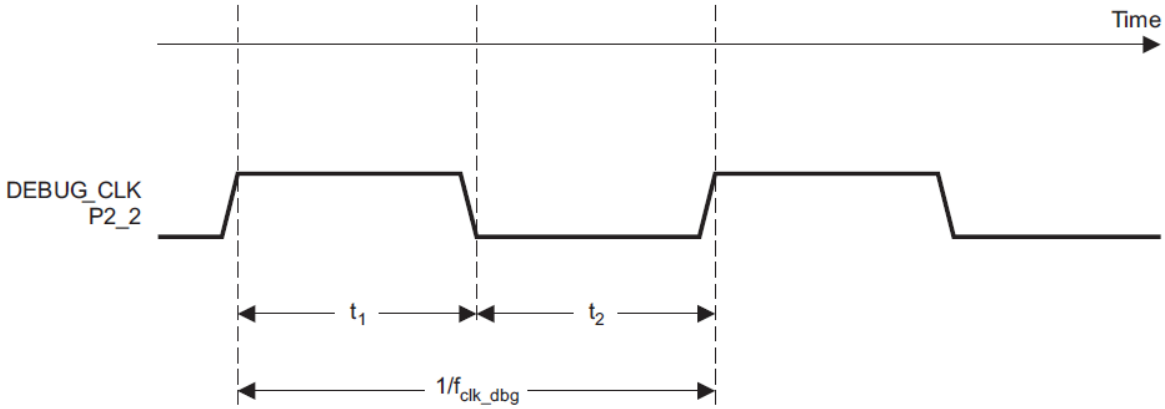

Figure 1 **Debug Clock – Basic Timing**

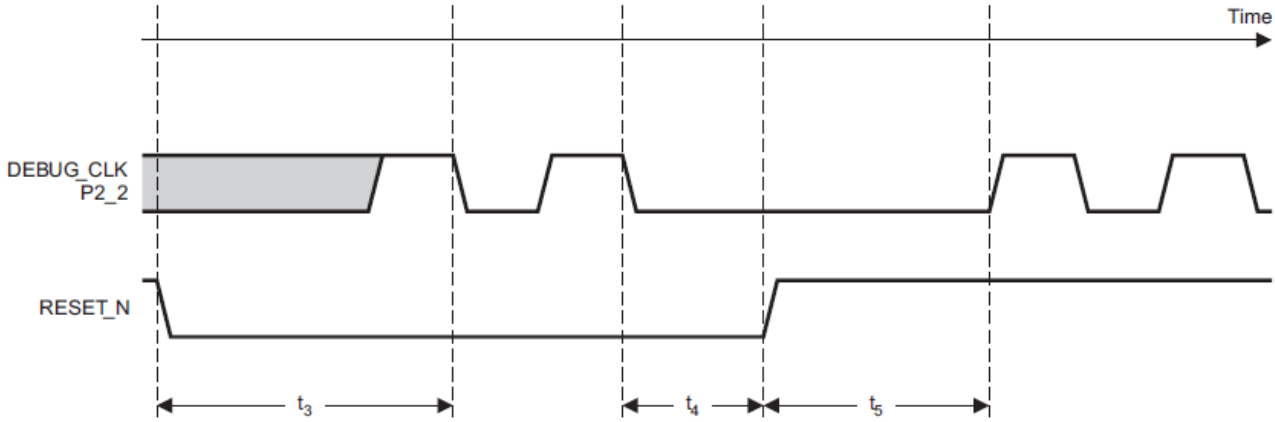

Figure 2 **Debug Enable Timing**

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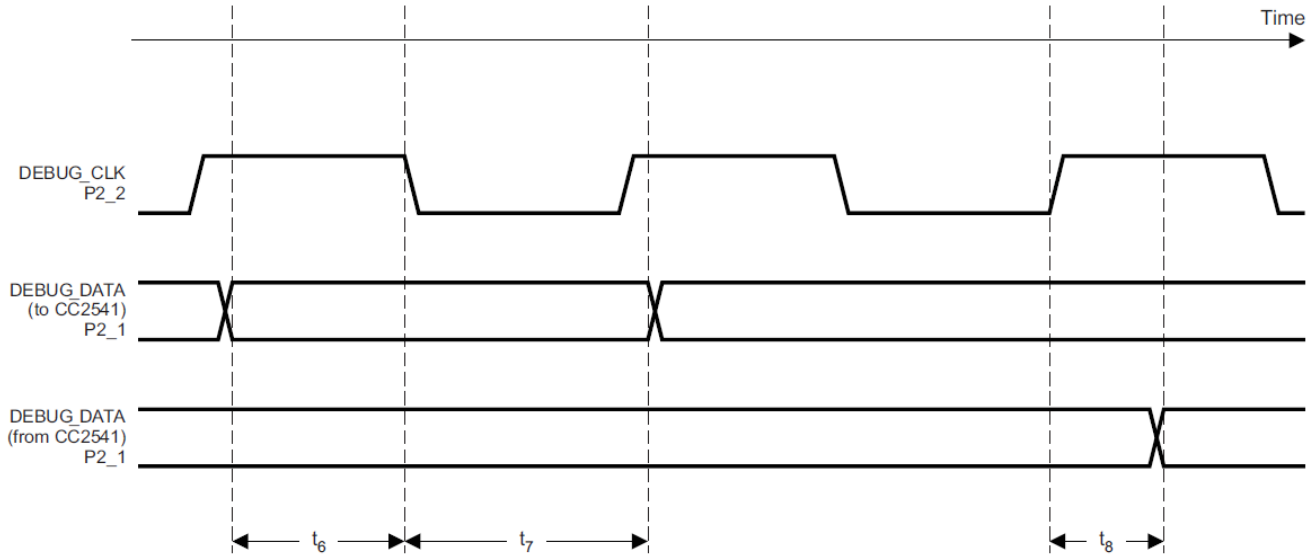

Figure 3 **Data Setup and Hold Timing**

DC Characteristics

T_A = 25°C, V_{DD} = 3.0~3.6 V

PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNITS	NOTE
Logic-0 input voltage		---	---	0.5	V	
Logic-1 input voltage		2.5	---	---	V	
Logic-0 input current	Input equals 0 V	-50	---	50	nA	
Logic-1 input current	Input equals VDD	-50	---	50	nA	
I/O-pin pullup and pulldown resistors		---	20	---	kΩ	
Logic-0 output voltage, 4-mA pins	Output load 4 mA	---	---	0.5	V	
Logic-1 output voltage, 4-mA pins	Output load 4 mA	2.4	---	---	V	
Logic-0 output voltage, 20-mA pins	Output load 20 mA	---	---	0.5	V	
Logic-1 output voltage, 20-mA pins	Output load 20 mA	2.4	---	---	V	

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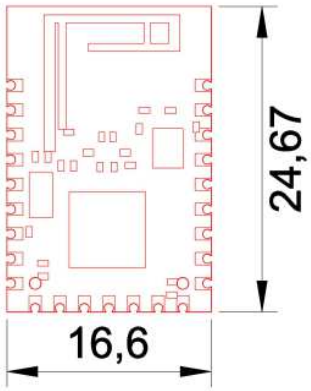
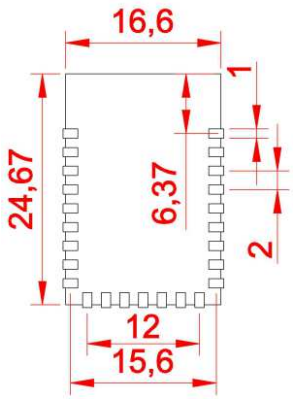
Dimension: (unit=mm)



Soldering Pad: (unit=mm)



Pin Assignment

1	GND	6	P17	11	GND	16	P02	21	P04
2	GND	7	P16	12	P13	17	P10	22	P01
3	REST	8	P15	13	P12	18	P07	23	P00
4	P22	9	P14	14	P11	19	P06	24	VDD
5	P21	10	VDD	15	P03	20	P05	25	GND

Pre-programmed Code

Ordering Product Number	Pre-load Function	Features
AO-1504	BLE to UART (PCB Antenna)	1. Support user define baud rate 9600~115200bps,8,N,1. 2. Suitable for various types of M2M data transmission. 3. Data transparent function
AO-1504A	BLE to UART (External Antenna)	1. Support user define baud rate 9600~115200bps,8,N,1. 2. Suitable for various types of M2M data transmission. 3. Data transparent function

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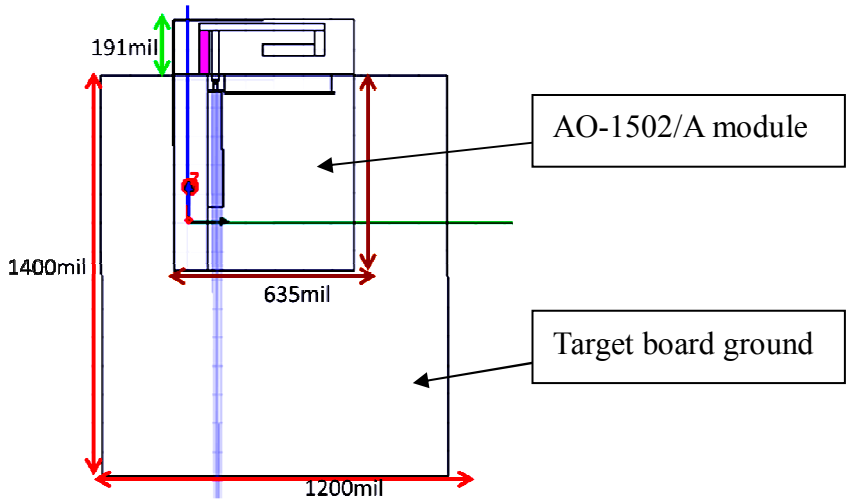
Application Notes

1. Note that around the antenna on the PCB board can not exist any circuit layer including the front and back board.
2. When AO-1502/A module is mounted to the target board, need to match the target board design to achieve a better antenna performance. The matching condition is as the follows.

Target board ground size	1200x1400mil
Module PCB ground size	625x910mil
Module PCB thickness	1.6mm
Target board thickness	1.0mm



3. The comparison of ideal and measured data

	Ideal Data	Measured Data
Center Frequency	2.45GHz	2.45GHz
S11(2.45GHz)	<-10dB	-29.679dB < -10dB
BW(on Board Antenna)	180MHz	100MHz

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